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ABSTRACT

Relationships among attitude toward mathematics, mathematics background, and junior college transfer versus non-transfer status upon competency in elementary mathematics were investigated using multiple linear regression techniques. Instruments for collecting data included a mathematics placement test, the "Mathematics Attitude Scale" by Aiken, and a questionnaire designed to gather information on mathematics background and the number of hours transferred from a junior college. Subjects were 78 entering elementary education majors at the University of Southern Mississippi. Significant relationships were found to exist between competency in elementary mathematics, the criterion variable in all analyses, and attitude toward mathematics as well as competency in mathematics and mathematics background. No significant relationship was established between junior college transfer status and mathematics competency. Comparison of the means further indicated that the stronger the background in mathematics, the higher the mathematics competency score. (Author/MS)

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Factors Influencing Competency

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FACTORS INFLUENCING COMPETENCY IN MATHEMATICS AMONG ENTERING ELEMENTARY EDUCATION MAJORS

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ABSTRACT

Relationships among attitude toward mathematics, mathematics background, and junior college transfer versus non-transfer status upon competency in elementary mathematics were investigated using multiple linear regression techniques. Instruments for collecting data included a mathematics placement test, the Mathematics Attitude Scale by Aiken, and a questionnaire designed to gather information on mathematics background and the number of hours transferred from a junior college. Significant relationships were found to exist between competency in elementary mathematics, the criterion variable in all analyses, and attitude toward mathematics as well as competency in mathematics and mathematics background. No significant relationship was established between junior college transfer status and mathematics competency. Comparisons of the means further indicated that the stronger the background in mathematics, the higher the mathematics competency score.

Today as never before students need a thorough background in mathematics, understanding the concepts and processes involved. This competency can only be gained from teachers who are themselves comfortable with the subject they teach and who exhibit positive attitudes toward that subject. If mathematics is to be taught so that children acquire real understanding of processes and concepts, it seems obvious that teachers of mathematics must possess these understandings before they attempt to transmit them to their students.

As early as 1953, in an attempt to identify problems elementary teachers have in teaching arithmetic, Orleans and Wandt found that many teachers rely on rote applications and short-cuts with little understanding of the concepts involved. These practices are still occurring in elementary classrooms. Being a teacher or having experience teaching arithmetic simply does not guarantee a thorough knowledge of the fundamentals of mathematics. Many teachers do not understand concepts enough to verbalize an explanation to their students (Gibney, Ginther & Pigge, 1970, 1980; Olson, 1977; Stores, 1977).

The average elementary teacher in America is a woman under 40 years of age who has been teaching 10 years or less. Her background generally consists of two semesters of high school

algebra and geometry and two college mathematics courses. She usually also has had one methods course in teaching arithmetic. She generally belongs to no mathematics association and surprisingly, she has observed someone else teaching mathematics only two or three times at most (Aichele, 1978).

This presents a frightening picture. If teachers have not acquired understandings in mathematics before they start their careers, how will most hope to gain these understandings during their careers? Teacher education institutions simply are not meeting the needs of preservice teachers of mathematics by the limited requirements of one math course and one methods course (Dossey, 1981; Swadener, 1978).

By identifying deficiencies among preservice teachers and the meaningful re-teaching of concepts, understanding of mathematics can be greatly improved (Stones, 1977; Vance, 1978). Furthermore, after meaningful learning occurs, a significant change is frequently noted in the attitude of preservice teachers. A more positive appreciation for mathematics is reflected in their teaching.

The teaching-learning environment is one in which interactions of attitudes takes place (Bulmahn & Young, 1982; Fennema, 1982; Moser, 1984, Reyes, 1980; Suydam, 1984). Since this first happens in the elementary school, the attitudes of both

the teacher and the students are important. By far, the attitude of the teacher may be the most important contributing factor to a child's developing appreciation for mathematics. In his book, Learning and Teaching Arithmetic, Banks (1964) observes that:

"The teacher who feels insecure, who dreads and dislikes the subject, for whom arithmetic is largely rote manipulation, devoid of understanding, cannot avoid transmitting her [sic] feelings to the children. . . . On the other hand, the teacher who has confidence, understanding interest and enthusiasm for arithmetic has gone a long way toward insuring success." (p. 17)

METHODOLOGY

Subjects

In an attempt to identify factors influencing the competency of preservice elementary mathematics teachers, seventy-eight entering elementary education majors at the University of Southern Mississippi (USM) participated in a study which was designed to determine the relationships between and among attitudes toward mathematics, mathematics background, and junior college transfer status to competency in mathematics.

Instruments

Entering elementary education majors at this university are required to take a placement test in mathematics which identifies

students who are having difficulties. This test of computational and geometric skills contains sixty items. Students whose score is below forty (66.7%) are advised into a developmental mathematics course for elementary majors before continuing with regular mathematics or a mathematics methods course.

Insert Figure 1 about here

Items on the Math Placement Test cover the follow categories:

- 1) addition and subtraction of whole numbers
- 2) multiplication of whole numbers
- 3) division of whole numbers
- 4) number theory
- 5) introduction to fractions
- 6) addition and subtraction of fractions
- 7) multiplication and division of fractions
- 8) introduction to decimals
- 9) division of decimals
- 10) percent
- 11) ratio and proportion
- 12) geometry

Each category contains a minimum of four items. All items are

computational and multiple choice options are given.

Attitude toward mathematics was determined by use of the Mathematics Attitude Scale by Lewis Aiken. This scale is comprised of twenty statements, ten of which connote negative attitudes and ten of which connote positive attitudes. Subjects are asked to respond on a Likert type scale to each of the twenty statements. Response alternatives are weighted from 4 (strongly agree) to 0 (strongly disagree) for positive items. The weights must be reversed for negative items. A person's score is the sum of his weighted responses. High scores reflect positive attitudes toward mathematics. A reliability measure of 0.94 has been established for this test (Aiken, 1961).

A questionnaire comprised of items related to mathematics background and junior college transfer status was administered. Respondents were asked to identify high school as well as college mathematics coursework and to respond to items relating to transfer from a junior college.

Insert Figure 2 about here

Mathematics coursework was divided into three categories:

- 1) Weak mathematics background included courses completed

in high school: general math, business math or algebra I only.

2) Average mathematics background was limited to combinations of completed courses from the above category and including algebra II or geometry.

3) Strong mathematics background included combinations from both other categories, and high school trigonometry or calculus, and/or college level mathematics courses.

Questions pertaining to junior college transfer status were included. Students were asked to indicate whether they had attended a junior college and to indicate the number of hours they transferred to the participating university.

Design of the Study

Data was processed using regression analysis, correlation techniques, and analysis of variance. The following hypotheses were tested:

- 1) There is a significant relationship between the criterion variable of competency in elementary mathematics among prospective elementary education majors and the composite set of predictor variables of attitude toward mathematics, mathematics background, and junior college transfer status.
- 2) There is a significant independent relationship between

the criterion variable of competency in elementary mathematics and the predictor variable of attitude toward mathematics when the remaining variables of mathematics background and junior college transfer status are held constant.

- 3) There is a significant independent relationship between the criterion variable of competency in elementary mathematics and the predictor variable of mathematics background when the remaining variables of attitude toward mathematics and junior college transfer status are held constant.
- 4) There is a significant independent relationship between the criterion variable of competency in elementary mathematics and the predictor variable of junior college transfer status when the remaining variables of attitude toward mathematics and mathematics background are held constant.

A multiple linear regression equation using seven variables, including one criterion variable was formed. Mathematics background and junior college transfer status formed groups of variables. Subgroups within these groups were considered in descriptive statistical procedures. Predictor variables of

attitude toward mathematics, mathematics background, and junior college transfer status were dropped systematically from the full model to determine their effect on the overall predictive efficiency of the criterion, competency in elementary mathematics. F-tests were used to compare the full and restricted models. Hypotheses were accepted or rejected on the basis of these F tests.

Results of the Study

Estimates of performance for the criterion variable competency in mathematics, were computed using means and standard deviation. Table 1 presents the results of these computations. In this study, a mean competency score of 39.9 was achieved with a standard deviation of 9.4.

Insert Table 1 about here

For the variable mathematics background, the subgroup strong background showed the highest mean score ($\bar{X} = 43.8$, $SD = 8.2$). Subjects with average background had the next highest mean score ($\bar{X} = 39.5$, $SD = 8.3$). The subgroup having the weakest background also had the lowest mean score ($\bar{X} = 29.9$, $SD = 11.2$).

The majority of the students (59.7%) had average backgrounds

in mathematics before entering the elementary education program. A percentage of 29.9 had strong backgrounds. The remaining 10.4% had weak mathematics backgrounds.

The number of subjects was divided almost equally on the variable junior college transfer status (50.6% and 49.4%). Their mean scores also showed a remarkable likeness. Junior college transfer students scored a mean of 40.4, $SD = 9.0$ and non-transfer student scored a mean of 39.6, $SD = 9.8$.

Table 2 presents the means and standard deviations for the variable, attitude toward mathematics, reported by categories. By comparing the results, it can be seen that as background in mathematics increased, attitude toward mathematics became more positive (weak background $\bar{X} = 25.5$, $SD = 9.2$; strong background $\bar{X} = 48.2$, $SD = 19.0$). Attitude toward mathematics had no observable relation with transfer status (non-transfer students $\bar{X} = 40.4$, $SD = 18.3$; transfer students $\bar{X} = 39.3$, $SD = 19.2$).

Insert Table 2 about here

Attitude toward mathematics has been shown in previous studies to be related to competency in mathematics. A coefficient of correlation of .56 was obtained in this study.

Mathematics background was broken into sub-categories of strong, average, and weak background. Dummy coding was used to obtain these sub-categories in the intercorrelation matrix. The relation of strong background and the criterion variable competency in elementary mathematics was negative ($-.36$). This can be interpreted as showing that there is a relation between background in mathematics and competency in mathematics. Little relation was evident between transfer status and competency. The correlations were $.02$ and $-.02$, respectively.

Table 4 shows coefficients of correlation between attitude toward mathematics and the predictor variables. It can be seen that mathematics background shows a definite relationship to attitude. Again, a negative relation is seen in weak background ($-.26$) and is offset by a positive relation from strong background ($.29$). This finding supports earlier studies that a relationship exists between mathematics background and attitude. No significant relations were found between transfer status and attitude toward mathematics.

Four hypotheses were formulated and tested using multiple linear regression techniques. Table 5 shows a summary of the results tabulated for each hypothesis. A significant relationship was found to exist between the criterion variable of competency in

elementary mathematics and the selected predictor variables of attitude toward mathematics, mathematics background, and junior college transfer status. Hypothesis 1 was accepted ($F = 10.5$, $df = 4,72$; $p < .01$).

Insert Table 5 about here

Significant independent relationships were found to exist between the criterion variable of competency in elementary mathematics and the selected predictor variable of attitude toward mathematics when the remaining variables were held constant.

Hypothesis 2 was accepted ($F = 22.0$, $df = 1,72$; $p < .01$).

Hypothesis 3 was accepted ($F = 3.3$, $df = 2,72$; $p < .05$).

This hypothesis indicated that a significant independent relationship existed between mathematics background and competency in mathematics when the remaining predictor variables were held constant.

Junior college transfer status was found to have no bearing on competency in elementary mathematics ($F = .07$, $df = 1,72$; $p > .05$). Hypothesis 4 was rejected.

Predictive strength of the various variables was determined using the full scale iteration model (Table 6). The predictor

variables were found to account for 36.8% of the total variance. Attitude toward mathematics accounted for 31% of the variance and when combined with weak mathematics background, another 5% was accounted for. Strong mathematics background when combined with attitude toward mathematics and weak mathematics background was shown to predict another 1% of the total variance. Junior college transfer status made no contribution. The remaining 63.2% of the original variance is unexplained.

Insert Table 6 about here

SUMMARY AND CONCLUSIONS

The criterion variable of competency in mathematics is illusive and studies dealing with this area should carefully consider all aspects of what is being tested. In this study, significant relationships were found between and among competency in mathematics, mathematics background, and attitude toward mathematics. No relationship was found to exist between junior college transfer status and mathematics competency.

Most entering elementary education majors involved in this study had an average mathematics background limited to

combinations of courses in high school general math, business math, algebra I and algebra II or geometry. Comparison of the means show that, as expected, the stronger the background in mathematics, the higher the competency score.

Attitude toward mathematics was shown to be a strong contributor to competency. These findings yield considerable implications for the need for positive attitudes on the part of inservice teachers. Further studies should be made concerning the transfer of teacher attitudes to the students.

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FIGURE 1

MATHEMATICS PLACEMENT TEST

FOR ELEMENTARY EDUCATION MAJORS (Sample Items)

GENERAL DIRECTIONS:

This is a test of some of the understanding, skills, and abilities you have been developing in school. Your score will be the total number of correct answers you mark. Wrong answers will not be counted against you.

Each problem in this test is followed by five suggested answers. Read each problem and then decide which one of the five suggested answers is correct.

EXAMPLE:

$$\begin{array}{r} 54 \\ -48 \\ \hline \end{array}$$

A. 6

B. 7

C. 16

D. 102

E. None of the above

Answer

A B C D E

The correct answer to this problem is lettered A, so space A is marked.

Mathematics Placement Test (continued)

SAMPLE PROBLEMS:

1. $\frac{2}{3} + \frac{3}{4} + \frac{0}{7} =$

A. $1 \frac{7}{12}$

D. $\frac{5}{14}$

B. $1 \frac{5}{12}$

E. None of the above

C. $\frac{5}{84}$

2. If X is 5, then $(8 - X)(10 - X) =$

A. 15

C. 45

E. None of the above

B. 30

D. 0

3. $33 \frac{1}{3}\%$ of 12 =

A. 3

C. 12

E. None of the above

B. 6

D. 4

4. 43.7986 rounded off to the nearest hundredth is:

A. 43.79

C. 43.7

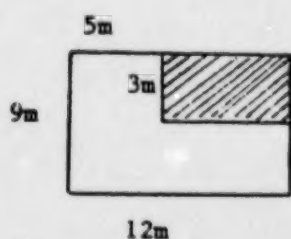
E. None of the above

B. 43.80

D. 43.799

Mathematics Placement Test (continued)

5. The area of the shaded region below is:



- | | |
|----------------------|----------------------|
| A. 108 square meters | D. 45 square meters |
| B. 60 square meters | E. None of the above |
| C. 42 square meters | |

FIGURE 2

QUESTIONNAIRE

The purpose of this questionnaire is to collect information that will be used in a research study on math understanding by elementary education majors. All answers will be held in strict confidentiality. The questionnaires will be destroyed after the results are tabulated.

Instructions:

Please check the courses in mathematics that you have had in high school and/or college.

COURSE		COURSE	
General Math I	___	Algebra II	___
General Math II	___	Geometry	___
Business Math I	___	Trigonometry	___
Business Math II	___	Calculus	___
Algebra I	___	College Algebra	___
Other _____			
Describe			

Have you transferred from a junior college: Yes ___ No ___

If you have transferred, approximately how many hours were transferred? ___

Age: ___ Sex: ___ M ___ F

Factors Influencing Competency

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TABLE 1

MEANS AND STANDARD DEVIATIONS FOR THE CRITERION VARIABLE, COMPETENCY
IN MATHEMATICS, REPORTED BY VARIABLES

Variable	<u>n</u>	<u>Z of N</u>	Mean	<u>SD</u>
Competency in				
Elementary Mathematics	77	100	39.8	9.4
Mathematics Background				
Weak	8	10.4	29.9	11.2
Average	46	59.7	39.5	8.3
Strong	23	29.9	43.8	8.2
Junior College Transfer				
Status				
Non-Transfer	39	50.6	39.6	9.8
Transfer	38	49.4	40.0	9.0

Factors Influencing Competency

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TABLE 2

MEANS AND STANDARD DEVIATIONS FOR THE PREDICTOR VARIABLE, ATTITUDE TOWARD MATHEMATICS, REPORTED BY VARIABLES

Variable	<u>n</u>	<u>X of N</u>	Mean	<u>SD</u>
Attitude Toward				
Mathematics	77	100	39.9	18.6
Mathematics Background				
Weak	8	10.4	25.5	9.2
Average	46	59.7	38.2	17.9
Strong	23	29.9	48.2	19.0
Transfer Status				
Non-Transfer Students	39	50.6	40.4	18.3
Transfer Students	38	49.3	39.3	19.2

TABLE 3

COEFFICIENT OF CORRELATION BETWEEN COMPETENCY IN MATHEMATICS AND
THE PREDICTOR VARIABLES

Predictor Variable	Pearson's r
Attitude	.56
Mathematics Background	
Strong	.28
Average	-.04
Weak	-.36
Transfer Status	
Non-Transfer Students	.02
Transfer Students	-.02

TABLE 4

COEFFICIENT OF CORRELATION BETWEEN ATTITUDE TOWARD MATHEMATICS AND
PREDICTOR VARIABLES

Predictor Variable	Pearson's <u>r</u>
Mathematics Background	
Strong	.29
Average	-.11
Weak	-.26
Transfer Status	
Non-Transfer Students	-.03
Transfer Students	.03

TABLE 5

SUMMARY OF REGRESSION ANALYSIS FOR CRITERION AND PREDICTOR VARIABLES

Hypothesis	R^2	df	F-ratio	p	Decision
H ₁ Competency in mathematics with attitude, background, and transfer status	.3682 ^a	4,72	10.488	<.01	accept
H ₂ Competency in mathematics with attitude toward mathematics	.1927	1,72	21.961	<.01	accept
H ₃ Competency in mathematics with mathematics background	.0580	2,72	3.303	<.05	accept
H ₄ Competency in mathematics with junior college transfer status	.0007	1,72	.074	>.05	reject

^aThis value represents the total variance accounted for by the predictor variables. The predictor variable interaction effect is obtained by subtracting the sum of the R^2 values of H₂, H₃ and H₄ from this number.

Table 6

ITERATION SEQUENCES FOR POSITED MODELS

		<u>RSQ</u>
Full Model:	Hypothesis 1	
Combined variables	2. Attitude	.309
to competency	5. Weak background	.359
	3. Strong background	.368
Restricted Model 1:	Hypothesis 2	
Attitude to	5. Weak background	.132
competency	3. Strong background	.175
Restricted Model 2:	Hypothesis 3	
Math background to	2. Attitude	.309
competency		
Restricted Model 4:	Hypothesis 4	
Transfer status to	2. Attitude	.309
competency	5. Weak background	.359
	3. Strong background	.368